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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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If no title is shown please refer to the description.
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DRILL BIT

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DRILL BIT

The present invention relates to a drill bit comprising one or more rock cutting elements arranged to cut a bore hole of a nominal drilling diameter in a subterranean formation in a drilling direction by rotating the drill bit in the subterranean formation about an axis corresponding to the drilling direction.

Such a drill bit can be a rotary bit, and in particular a rotary drag bit. More in particular, the drill bit can be a so-called reamer which is generally capable of drilling out a shoe track of a casing shoe.

An example of a reamer is disclosed in WO 02/07994.

When drilling a bore hole in a subterranean formation, in particular to form a well for exploration or for production of mineral hydrocarbons, a steel casing is commonly set at a certain stage in the drilling operation in order to secure an already drilled section of the bore hole before drilling deeper. After setting the casing, a drill bit must be run through the casing in order to reach the bottom of the hole where the drilling operation can be continued. Running the drill bit through the casing involves a risk of damaging the casing wall, in particular since normally a fresh drill bit is selected that has sharp rock cutters, usually in the form of shear cutters, which generally are much harder than the casing steel and are even capable of cutting through a casing if desired. Since a casing wall is often intended to remain inside the bore hole, it is undesirable to cause casing wall damage.

Moreover, a casing is often cemented. Commonly applied cementing procedures required that some cement as well as auxiliary equipment such as cementing plugs remain behind inside the casing shoe. This must be drilled out in order to expose the bottom of the bore hole for continued drilling. It is a problem to drill out the casing shoe, because there is a risk of damaging the casing shoe with the rock cutters. This is particularly the case if it is desired to leave as little as possible cement remains inside the casing shoe.

In accordance with the invention, there is provided a drill bit comprising one or more rock cutting elements arranged to cut a bore hole of a nominal drilling diameter in a subterranean formation in a drilling direction by rotating the drill bit in the subterranean formation about an axis corresponding to the drilling direction, the drill bit further comprising at least one protection member which is over gauged relative to the nominal drilling diameter before the at least one protection member contacts the subterranean formation when the subterranean formation is being cut by the one or more rock cutting elements.

Since the at least one protection member is over gauged relative to the nominal drilling diameter while the bit is run through the casing, the protection member will contact the casing wall thereby preventing the one or more rock cutting elements contacting the casing wall. Due to a standoff provided by the protection member, damage to the casing is avoided.

The protection member can suddenly or gradually seize to be over gauged when it starts contacting the subterranean formation, so that the bore hole can be

drilled with its nominal drilling diameter without being obstructed by the protection member.

In an attractive embodiment, the at least one protection member is sacrificial when it contacts the subterranean formation. This can be achieved for instance by providing the protection member with a material having a balanced wear resistance that is on one hand sufficiently wear resistant to prevent the rock cutting elements to contact the casing inner surface and on the other hand wearable against the subterranean formation once the drill bit is outside the casing and drills the formation.

Preferably, the one or more rock cutting elements and the at least one protection member are provided on a drill bit body which is outwardly movable with respect to the axis. Herewith a reamer is provided of which the drill bit body can be brought in contact with the casing wall such as to ream an as large as possible cross sectional area inside the casing. The cement is primarily drilled out by the rock cutting capability of the one or more rock cutting element, while the protection member ensures a sufficient standoff between the rock cutting elements and the casing wall. At the same time the protection member can function as a scraper for scraping off potential remains of cement adhered to the inside of the casing wall.

The invention will be described hereinafter in more detail and by way of example with reference to the accompanying drawings in which:

Fig. 1 shows a schematic view of a part of the drill bit according to one embodiment of the invention;

Fig. 2 shows a schematic view of a part of the drill bit according to another embodiment of the invention;

Fig. 3 shows a schematic view of a part of the drill bit according to still another embodiment of the invention;

Fig. 4 (parts a to d) shows a schematic side view of drill bit parts according to the invention; and

Fig. 5 shows an expandable casing shoe.

In the drawings, like reference numerals refer to like parts.

Fig. 1 shows a schematic view of a part of a drill bit, which is arranged to be rotated around axis A, which axis is parallel to a drilling direction. The drill bit as depicted is a so-called reamer, and it comprises a drill bit body 2 in the form of an arm, which drill bit body 2 may be held by support member 1. A plurality of rock cutting elements 3 is provided on the bit body 2 in the form of shear cutting elements. Rotating of the drill bit around axis A inside a bore hole can result in rock cutting to continue the bore hole with a nominal drilling diameter.

In the shown embodiment, the drill bit body 2 is radially moveable with respect to the axis A. This allows for lowering of the drill bit through a casing tubing in a retracted condition, and expanding the drill bit when it is lowered beyond the casing to enable drilling a hole having a larger nominal diameter than the inner diameter of the casing tubing. The expanding can be driven in any way, for instance it can be mechanically driven or it can be driven using mud circulation pressure.

The drill bit body 2 is provided with a protection member 6, which is over gauged relative to the nominal drilling diameter. In the embodiment of Fig. 1, this is achieved by arranging the protection member 6 to protrude radially outward relative to the rock cutting elements 3.

The protection member 6 preferably has a blunt shape, such as a rounded shape or a flat shape with a chamfer. When lowering the drill bit of Fig. 1 through a casing tubing, the protection member 6 will provide a standoff of the rock cutting elements 3 from the inner wall of the casing tubing and thereby prevent the rock cutting elements 3 from damaging the inside wall of the casing.

The protection member 6 is preferably formed of a material that is sufficiently wear resistant to enable providing the standoff during a sufficient amount of time.

The protection member 6 should be over gauged before it contacts the subterranean formation when the subterranean formation is being cut by the rock cutting elements 3. But preferably the protection member 6 suddenly or gradually seizes to be over gauged after is contacts the subterranean formation. Otherwise, the drill bit will not smoothly rotate inside the bore hole.

This can be achieved by retractably arranging the protection member 6 relative to the bit body 2 or the rock cutting elements 3.

A simpler and cheaper alternative is to sacrificially arrange the protection member 6, such that it is sacrificed once it contacts the subterranean formation being cut. This can be achieved by a proper selection of the material from which the protection member 6 is formed in relation to the formation to be cut. Certain suitable tungsten-carbide grades or hardened and/or heat-treated steel grades are available which are sufficiently wear resistant to provide the desired standoff and protection of the casing, and wear against the formation. The wear resistance of tungsten-carbide can be designed by application of a specific cobalt content and/or particle

size distribution of the alloy material. An advantage of using steel for the protection member is that it can be machined as an integral part of the bit body.

Fig. 2 shows an alternative embodiment, wherein the bit body 2 is additionally provided with a permanent gauge-protecting area 4 up hole with respect to the trimmer cutters, which can be made from a hard material.

Fig. 3 shows yet another embodiment of the invention, wherein the protection member 6 comprises a gauge-protecting area 14 facing away from axis A. This has as an advantage that the bit body 2 can be as short as in the embodiment of Fig. 1, or at least shorter than in the case of Fig. 2, where the protection members 6 are located up hole displaced relative to the protection area 4.

The gauge-protecting area 14 can be provided in the form of a gauge-protecting layer 14 that is integrated with the protection member 6 having a layered structure. The layered structure further comprises a sacrificial layer 16 to perform the casing protection function and which is sacrificial until the gauge-protecting layer 14 is exposed.

Fig. 4 shows schematic side views of the bit bodies 2 provided with protection members. In Figs. 4a and 4b two protection members 6 are provided in the form of rounded inserts above the rock cutters 3. In Fig. 4a the protection members 6 are axially aligned above each other.

In Figs. 4c and 4d the protection members 8,9 are elongate members, either vertically directed (8) or slanted (9). The elongate members are formed of cylindrical inserts having essentially spherical ends.

Fig. 5 shows a schematic cross section of a lower end of a first casing member 10 having an expanded bell 11. A second casing member 12 is located under the first casing member 10 and partly protrudes into the expanded bell 11.

During the expansion and cementing processes of the first casing member 10, the enlarged diameter of the first casing bell 11 is filled with cement. During the drill out of the casing shoe, as much of the cement as possible should be removed from the bell 11 in order to enable a sealing connection between casing members 10 and 12. For the same reason, the inside wall of the bell 11 should be undamaged. The drill out operation should therefore not damage the inside wall surface of the bell 11.

The drill bit having the protection members is particularly advantageous in drilling out a casing shoe, because of its protection members providing a standoff between the rock cutters and the casing wall. It is even better when the protection member is shaped in the form of a blunt cutting element, because in such an embodiment the protection member also serves to assist in removing cement remains from the casing wall after the cement has been cut by the rock cutting elements. Alternatively, the protection member can be shaped as a scraper.

When such a protection member is provided on an expandable reamer, a drill out operation can be as follows. Firstly, the drill bit is lowered through the casing member until the cement is reached. The drilling out can then begin, with the bit in its retracted position until the enlarged section of the casing bell 11 is reached. An opening mechanism of the reamer is then to be triggered, while the drilling out is continued. Triggering will allow the bit bodies to expand or start

to expand, for instance using the mud circulation pressure as driving force, until the protection members engage with the casing bell 11 for cleaning cement remnants from the casing bell 11. When the drill bit finally reaches the formation below the casing bell 11, the bit can optionally be fully expanded for continued drilling.

Once the protection members contact the subterranean formation, the relatively low wear resistance of the protection members compared to that of the rock cutting elements causes them to wear at a high rate so that the negative impact of purposely designed poor cutting properties of the protection members on drilling performance is mitigated.

An alternative drill out procedure for cleaning the cement from the inner diameter of the bell section of the casing may be as follows. After lowering the drill bit through the casing member and reaching the cement, the cement is first drilled out with the reamer arms in their retracted positions until the expandable part of the bit is positioned just below the bottom of the casing shoe, or just below the bottom of the casing bell section 11. Then the opening mechanism of the reamer is triggered, and the expandable part of the bit is pulled back to the top of the bell section of the casing shoe. Once the expandable part of the bit has reached this position, circulation pressure is increased to ensure a sufficient contact force between the protection member and the inner diameter of the casing. Subsequently, the bell section is reamed downwards applying the mud circulation pressure. This way, any potential damage to the inner diameter of the casing caused by triggering of the expansion mechanism is avoided, and in addition the drilling

performance of the casing shoe is not limited by the circulation pressure that can be applied during the drilling out.

C L A I M S

1. Drill bit comprising one or more rock cutting elements arranged to cut a bore hole of a nominal drilling diameter in a subterranean formation in a drilling direction by rotating the drill bit in the subterranean formation about an axis corresponding to the drilling direction, the drill bit further comprising at least one protection member which is over gauged relative to the nominal drilling diameter before the at least one protection member contacts the subterranean formation when the subterranean formation is being cut by the one or more rock cutting elements.

2. Drill bit according to claim 1, wherein the at least one protection member is sacrificial.

3. Drill bit according to claim 1 or 2, wherein the at least one protection member is located displaced from the one or more rock cutting elements.

4. Drill bit according to any one of claims 1 to 3, wherein the at least one protection member is axially displaced in an up hole position with respect to the one or more rock cutting elements as seen in normal operation of the drill bit.

5. Drill bit according to any one of the previous claims, wherein the drill bit comprises a bit body and the at least one protection member is provided in the form of an insert in the bit body.

6. Drill bit according to any one of the claims 1 to 4, wherein the drill bit comprises a bit body and the at least one protection member is an integral part of the bit body.

7. Drill bit according to any one of the previous claims, wherein the at least one protection member is shaped in the form of a blunt cutting element.

8. Drill bit according to any one of the previous claims, wherein the at least one protection member has a rounded shape protruding outwardly as seen from the axis.

9. Drill bit according to any one of the previous claims, wherein the at least one protection member comprises a material that is sufficiently wear resistant to enable providing a standoff between the one or more rock cutting elements and a casing wall.

10. Drill bit according to any one of the previous claims, wherein the at least one protection member is shaped as a scraper, preferably suitable for scraping a layer of cement adhered to a steel casing wall.

11. Drill bit according to any one of the previous claims, wherein the drill bit further comprises a gauge-protecting area and the at least one protection member is located on the gauge-protecting area facing away from the axis.

12. Drill bit according to claim 11, wherein the at least one protection member has a layered structure comprising a sacrificial layer that is over gauged and a permanent gauge-protecting layer, such that the at least one protection member is sacrificial until the permanent gauge-protecting layer is exposed.

13. Drill bit according to any one of the previous claims, wherein the one or more rock cutting elements and the at least one protection member are provided on a drill bit body which is outwardly movable with respect to the axis.

A B S T R A C T

DRILL BIT

Drill bit comprising one or more rock cutting elements arranged to cut a bore hole of a nominal drilling diameter in a subterranean formation in a drilling direction by rotating the drill bit in the subterranean formation about an axis corresponding to the drilling direction, the drill bit further comprising at least one protection member which is over gauged relative to the nominal drilling diameter before the at least one protection member contacts the subterranean formation when the subterranean formation is being cut by the one or more rock cutting elements.

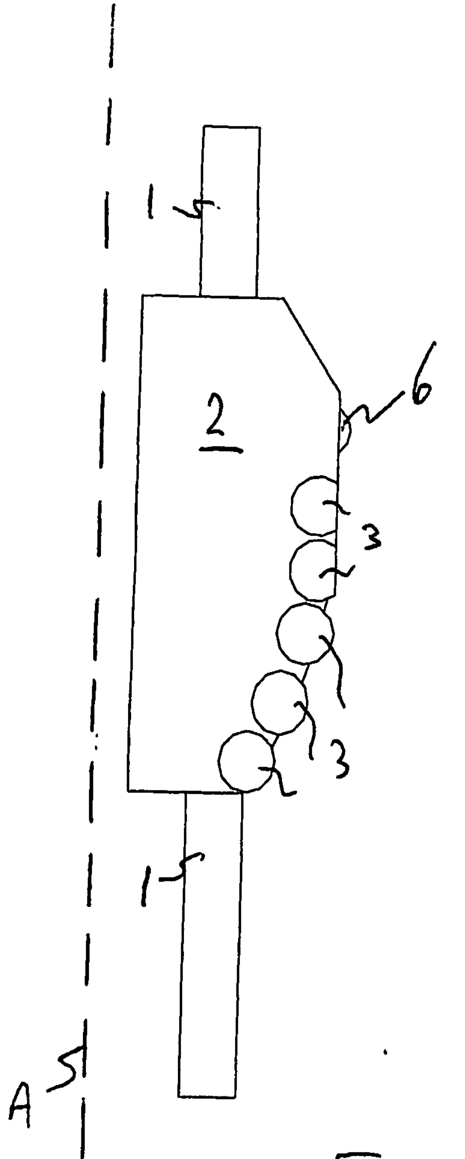


Fig. 1

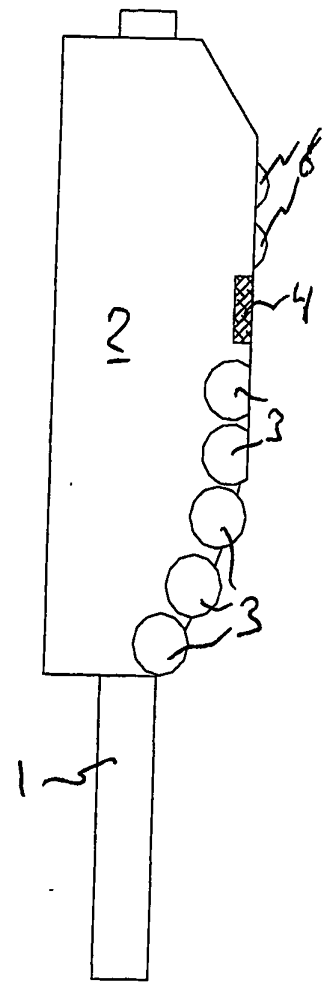


Fig. 2

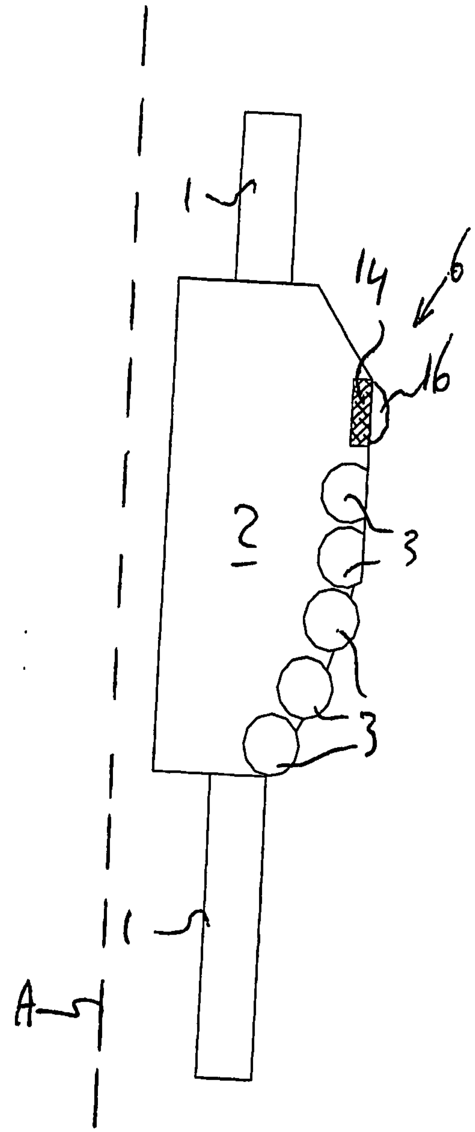


Fig. 3

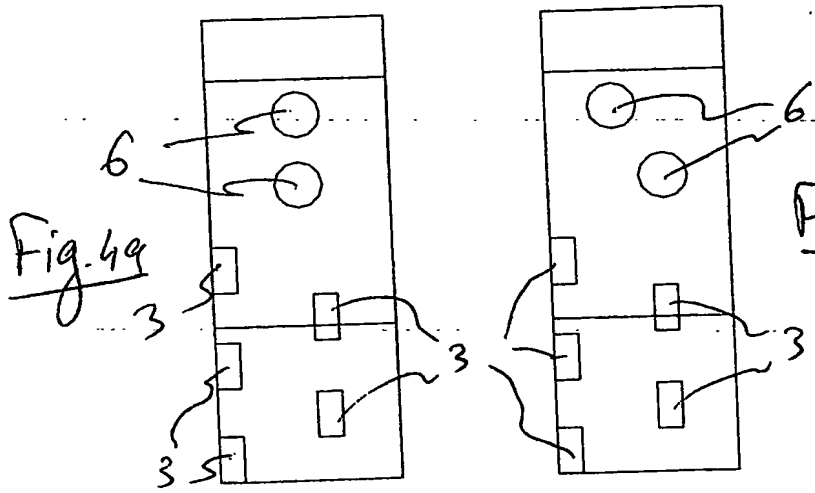


Fig. 4a

Fig. 4b

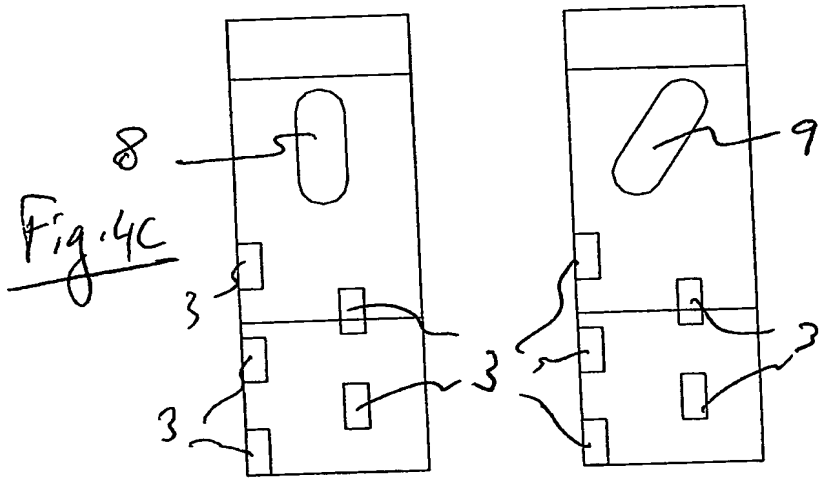
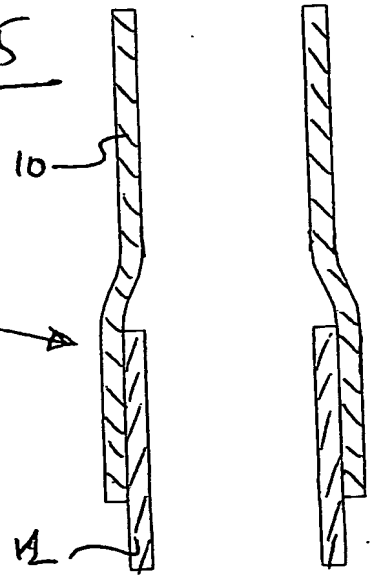


Fig. 4c

Fig. 4d

Fig. 5



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